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Surface Functionalization of Packaging Films To Promote Adhesion of Aqueous-Based Inks

DESCRIPTION OF THE TECHNOLOGY

With support from the Environmental Protection Agency's (EPA) Small Business Innovation Research (SBIR) Program, Sigma Technologies International, Inc., developed inexpensive, high-speed, inline technology and equipment for the treatment (i.e., functionalization) of film surfaces to promote adhesion of solventless and aqueous-based inks.

Surface functionalization is achieved by an appropriate combination of plasma treatment and thin (submicron) acrylate coating within a vacuum environment. Functionalization is performed inline at high speed using Sigma Technologies' proprietary equipment. The process begins with plasma treatment of one surface of the plastic film using a moderate energy flux with a suitable gas mixture. As the plastic film continues through the web-processing machinery, it can be metalized and coated or coated directly with a very thin layer of an acrylate-based monomer that is 100 percent active (i.e., no solvents). The monomer is deposited on the surface of the plastic film, then passed in front of an electron beam where the monomer is rapidly and completely polymerized. The functionalized film then is ready for printing, labeling, or other processing.

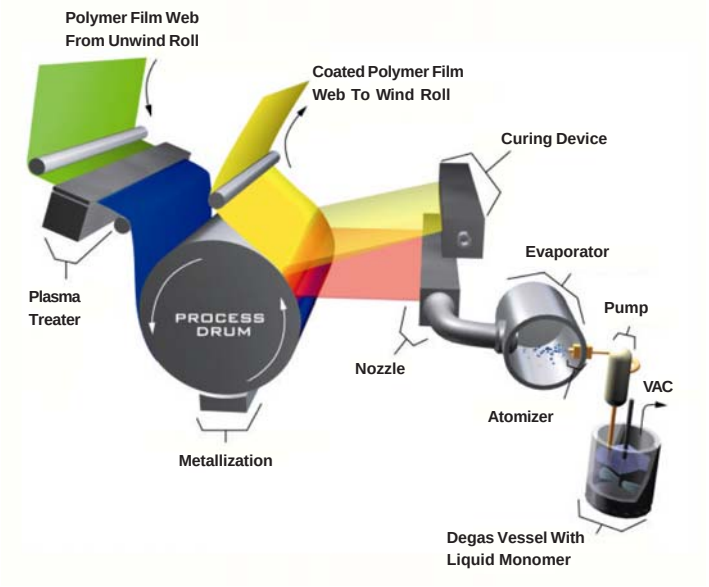
Sigma Technologies also has developed radiation-curable, acrylate monomers that either repel or attract water. Monomer blends can be tailored to meet the specific surface energy requirements of the client.

SIGNIFICANCE OF THE TECHNOLOGY

This technology offers the environmental benefit of reducing the dependence of the packaging film printing industry on solvent-based inks. Use of solvent-based inks results in the release of volatile organic compounds (VOCs)—particularly toluene—to the atmosphere. Toluene has been near the top of the Toxic Release Inventory List in recent years, with tens of millions of pounds released annually. Solvent-based inks are responsible for approximately 50 percent (by weight) of the VOCs emitted from a typical printer, and VOCs are regulated as criteria air pollutants under the Clean Air Act. Sigma Technologies' surface functionalization technology provides packaging film industry printers and converters with a pollution prevention alternative to the use of solvent-based inks. Use of this technology will eliminate the release of VOCs associated with the use of solvent-based inks. It also eliminates the need to dispose of waste solvent-based inks as hazardous wastes.

SBIR Impact

- **Sigma Technologies has developed inexpensive, high-speed, inline technology and equipment for surface functionalization of plastic film that promotes adhesion of aqueous-based and solventless inks.**
- **The technology eliminates the use of solvent-based inks by packaging film printers, preventing the release of VOCs to the atmosphere as well as the need to dispose of waste solvent-based inks as hazardous wastes.**
- **Functionalization of packaging films increases the metal "sticking coefficient" for metallized plastic packaging film, reducing the amount of metal wasted and the resulting disposal costs.**
- **The acrylate coating technology can be tailored to provide almost any surface energy desired on a plastic film substrate.**
- **SBIR funding helped Sigma Technologies obtain R&D commitments from major players in the packaging film industry to accelerate commercialization of this technology.**



Schematic of vaccum deposition of a polymer coating. First, the film is plasma treated to promote adhesion of the vaccum deposited coating. A reactive liquid monomer (one or more double bonds) then is degassed, atomized into a flash evaporator, converted to vapor, delivered to the film surface through a nozzle, condensed back into a liquid on the moving film surface, and finally cross-linked to polymer with an e-beam gun or UV lamp. A polymer layer can be deposited by itself, or before and/or after a metallized or sputtered layer.

In addition to eliminating the use of solvent-based inks, Sigma Technologies' surface functionalization process is more efficient for clients who metallize plastic packaging film following plasma treatment. Functionalization of packaging films increases the "sticking coefficient" for the metal in comparison to untreated film. That is, the percentage of the evaporated metal that condenses and adheres to the surface of the film is slightly higher for films that have been plasma treated. More efficient metal deposition means less metal is wasted, and waste disposal costs are reduced.

COMMERCIALIZATION SUCCESS

EPA SBIR funding significantly contributed to the success of Sigma Technologies' commercialization efforts. The Phase I project helped compile credible data and important findings, which resulted in R&D commitments from clients who are major players in the packaging film industry to run concurrently with the Phase II EPA SBIR effort. The SBIR funding, combined with the private sector efforts, helped Sigma Technologies to overcome technical and financial obstacles during Phase II and achieve successful commercialization of its equipment design and technology concept.

COMPANY HISTORY

Sigma Technologies International, Inc., is a technology company that provides a broad range of products and services. Sigma manufactures innovative turnkey coating and surface treatment systems for functionalizing material surfaces, and for producing multilayer thin-film coatings. The company also designs and manufactures instrumentation for customers in the optics, packaging, and energy storage markets. These include state-of-the-art optical densitometers for measuring optical density, coating thickness, and electrical resistivity of thin films; specialty power supplies; and partial-discharge data acquisition and analysis systems.

What is the SBIR Program?

EPA's Small Business Innovation Research (SBIR) Program was created to assist small businesses in transforming innovative ideas into commercial products. The SBIR Program has two phases—Phase I is the feasibility study to determine the validity of the proposed concept and Phase II is the development of the technology or product proven feasible in Phase I. EPA also offers Phase II Options to accelerate the commercialization of SBIR technologies and to complete EPA's Environmental Technology Verification (ETV) Program. For more information about EPA's SBIR Program and the National Center for Environmental Research, visit http://www.epa.gov/ncer/sbir.